WORLD FEDERATION OF NATIONAL MATHEMATICS COMPETITIONS

# 10th Congress of the World Federation of National Mathematics Competitions

Kuala Lumpur, Malaysia, 22–28 July 2026

WFNMC-10

# Book of Abstracts

# Scientific Committee

Krzysztof Ciesielski, *WFNMC Senior Vice-President, WFNMC Programme Committee Chair*

Robert Geretschläger, *WFNMC President*

Suhaimi Ramly, *Chair of Local Organizing Committee*

**Topic Group (TG) Chairs:**

TG1: Building Bridges between Problems of Mathematical Research and Competitions
Alexander Soifer

TG2: Creating Problems and Problem Solving
Hayk Sedrakyan

TG3: Competitions around the World (Focus on developing countries)
Paul Vaderlind

TG4: Technological Applications in Mathematics Competitions and Didactics
Lukas Donner

## Schedule

**Thursday, 23 July**

9:00 AM – 10:00 AM Opening ceremony & Welcoming Remarks
10:00 AM – 11:00 AM Plenary Lecture by Richard Elwes
11:00 AM – 11:30 AM Coffee Break
11:30 AM – 12:00 PM TG1 Alexander Soifer: Keynote by Chair
12:00 PM – 12:30 PM TG1 Kiril Bankov
12:30 PM – 1:00 PM TG1 Regis Prado Barbosa
1:00 PM – 2:30 PM Lunch
2:30 PM – 3:00 PM TG1 Miroslav Marinov (online)
3:00 PM – 3:30 PM ExP Omar Colón, Luis Cáceres
3:30 PM – 4:00 PM Coffee Break
4:00 PM – 4:30 PM TG1 Evgeny V. Khinko
4:30 PM – 5:15 PM TG1 Special Film Presentation (A. Soifer)
5:15 PM – 5:30 PM Introduction to Workshop

**Friday, 24 July**

9:00 AM – 9:30 AM TG2 Hayk Sedrakyan: Keynote by Chair (online)
9:30 AM – 10:00 AM TG2 Robert Geretschläger
10:00 AM – 10:30 AM TG2 Arno Mikaelyan, Advik Kishore (online)
10:30 AM – 11:00 AM TG2 Raphaël Pinarbasi
11:00 AM – 11:30 AM Coffee Break
11:30 AM – 12:00 PM TG2 Jacob Gechlik, Diya Gandhi, Shaurya Jain (online)
12:00 PM – 1:00 PM Plenary Lecture by Po-Shen Loh
1:00 PM – 2:30 PM Lunch
2:30 PM – 3:00 PM TG3 Paul Vaderlind: Keynote by Chair (online)
3:00 PM – 3:30 PM TG3 Maria Losada (online)
3:30 PM – 4:00 PM TG3 Krzysztof Ciesielski (online)
4:00 PM – 4:30 PM Coffee Break
4:30 PM – 5:30 PM Workshop

**Saturday, 25 July**

Excursion Day

**Sunday, 26 July**

9:00 AM – 10:00 AM Plenary Lecture by Alexander Soifer
10:00 AM – 10:30 AM TG3 Navid Safaei (online)
10:30 AM – 11:00 AM TG3 Agrey Kimaro
11:00 AM – 11:30 AM Coffee Break
11:30 AM – 12:00 PM TG4 Lukas Donner: Keynote by Chair (online)
12:00 PM – 12:30 PM TG4 Andrew Kepert, Elke Grinschgl, Lukas Donner
12:30 PM – 1:00 PM TG4 Matjaž Željko
1:00 PM – 2:30 PM Lunch
2:30 PM – 3:00 PM TG4 Robin Gludovatz, Yasmin Theile, Michael Fischer (online)
3:00 PM – 3:30 PM TG4 Evita Lerchenberger (online)
3:30 PM – 4:00 PM ExP Tim Sanders
4:00 PM – 4:30 PM Coffee Break
4:30 PM – 5:30 PM Workshop

**Monday, 27 July**

9:00 AM – 10:00 AM Plenary Lecture by Lê Anh Vinh
10:00 AM – 10:30 AM ExP Michael Fischer (online)
10:30 AM – 11:00 AM ExP Nicolás Atanes Santos (online)
11:00 AM – 11:30 AM Coffee Break
11:30 AM – 12:00 PM ExP Chris Wetherell
12:00 PM – 12:30 PM ExP Aidan Mozayeni (online)
12:30 PM – 1:00 PM ExP Athmane Dadi
1:00 PM – 2:30 PM Lunch
2:30 PM – 4:00 PM General Meeting of WFNMC (First Session)
4:00 PM – 4:30 PM Coffee Break
4:30 PM – 5:30 PM General Meeting of WFNMC (Second Session)
7:00 PM – 10:00 PM Gala Dinner

(ExP = Extra Presentation)

## Plenary lectures

Richard Elwes

University of Leeds, United Kingdom

R.H.Elwes@leeds.ac.uk

### Puzzles, Stories, and Very Large Numbers – Complementary Approaches to Mathematical Engagement

There are two main approaches to engage people in mathematics. The first is through puzzles, problems, games, and tricks. The other is through stories, surveys, and histories. The first is narrow but deep, the second broad but shallow. This is reminiscent of Freeman Dyson's division of research mathematicians into "birds" and "frogs", We will discuss these two complementary approaches, with a focus on moments where they work together: where an individual puzzle plays a starring role in a bigger story, the Seven Bridges of Königsberg being one famous example. Then we will look at some combinatorial puzzles which, via the unexpected appearance of some extremely large numbers, provide an accessible entry point into deep areas of mathematical logic.

Po-Shen Loh

Carnegie Mellon University, Pittsburgh, USA

po@expii.com

### After AI: From International Math Contests to a More Thought Full World

Earlier this month, the speaker used the latest publicly-released version of Anthropic's AI (Fable 5) to effortlessly solve 50+ past exams from the USA's AIME competition. These are very difficult 3-hour exams, given only to fewer than 10,000 of the highest-scoring students from the initial round of the USA's Olympiad system. Yet even among that rarefied group, most of those exceptional students cannot score more than about 25% on the exam. Today's AI considers it trivial.

What, then, is the purpose of these competitions now? Are they even selecting for people who will be useful contributors to society? More generally, what attributes will be the most valuable in this strange post-AI reality?

The speaker will share his observations from traveling the world, guest-teaching in hundreds of classrooms, a routine he started while serving as the national coach of the USA International Math Olympiad team.

He will describe a new systemic solution that he has created and implemented, which is centered around a philosophy for organizing society to thrive in the modern AI-dominated world. The unifying concept is to be Thought Full (https://thoughtfull.com). And the speaker's solution uses the math contest infrastructure to propagate it worldwide.

This solution brings together many different disciplines, ranging from math (of course), to performing arts, to video-gamer live-streaming, to politics, entrepreneurship, and philosophy.

Alexander Soifer

University of Colorado, USA

asoifer@uccs.edu

**Chromatic Number of the Plane Problem Yesterday, Today, Tomorrow, and Mathematical Olympiads**

30 years without Paul Erdős (1913–1996), In loving memory

Our last visit in person, Baton Rouge, Louisiana, February 22, 1996

*[I] can't offer money for nice problems of other people because then I will really go broke... It is a very nice problem. If it were mine, I would offer $250 for it.*

– Paul Erdős Boca Raton, February 6, 1992

*The unit distance graph in the plane ... is simple enough to describe to a nonmathematician, and so enigmatic that finding its chromatic number is a new four-color map problem for graph theorists.*

— Ronald L. Graham and Eric Tressler

*If Problem 8 [the chromatic number of the plane] takes that long to settle [as the Four-Color problem], we should know the answer by the year 2084.*

— Victor Klee and Stan Wagon

Did I whet your appetite?
Welcome to my talk for the rest of the story! :-)

Lê Anh Vinh

Vietnam Institute of Educational Sciences, Vietnam

vinhla@vnies.edu.vn

**Developing Mathematics Competition Ecosystems in Southeast Asia: From Talent Identification to Educational Impact**

Mathematics competitions play an important role in talent development and mathematics education. In Southeast Asia, these systems are at different stages of development. While some countries have built strong traditions in identifying and nurturing mathematical talent, others are actively expanding participation and strengthening pathways for students and teachers.

Drawing on Vietnam's experience and the wider regional context, this plenary talk explores how sustainable mathematics competition ecosystems can be developed. It considers key elements such as talent identification, teacher development, enrichment programmes, national competitions, international participation, curriculum connection, and institutional support. It also reflects on common challenges, including unequal access, limited teacher capacity, excessive focus on medals, early specialization, and the gap between competition mathematics and classroom learning.

The talk argues that mathematics competitions should not be seen merely as contests or medal pathways. When well designed, they can inspire students, support teachers, strengthen mathematical culture, and contribute to broader educational improvement. In the age of artificial intelligence, they also offer valuable opportunities to cultivate deep thinking, creativity, perseverance, and intellectual independence. The talk concludes by proposing ways for Southeast Asian countries to learn from one another and collaborate in building more inclusive and sustainable systems for mathematical talent development.

**Topic Group 1**

# Building Bridges between Problems of Mathematical Research and Competitions

Alexander Soifer

University of Colorado, USA

asoifer@uccs.edu

**Keynote by Chair:**
**Bridges Between Research Mathematics and The Soifer Mathematical Olympiad**

Mathematical research often includes magnitude of cases and great deal of computations. They seem far away from the spirit of mathematical Olympiads. However, a watchful eye of an Olympiad problem creator may find in these massive ore particles of gold and extract these golden ideas. We then dress up the sparkles, compose stories around them unlike those of Wonderland and offer the stories to inquisitive youthful Olympians. This new generation of Olympiad problems may inspire young minds to become mathematicians right away, especially when solved problems of this kind are afterwards presented as the first stations in the trains of thought, which in my Colorado Mathematical Olympiad books I named "Further Explorations". This is a two-way bridge; several times Olympiad problems inspired new mathematical research.

In *The Soifer (formerly Colorado) Mathematical Olympiad*, running so far for 42 years, we have been using Olympiad problems extracted from and inspired by research work. I will share with you here a few original problems that despite their considerable depth require no prior knowledge.

Kiril Bankov

University of Sofia and Bulgarian Academy of Sciences, Bulgaria

kbankov@fmi.uni-sofia.bg

**Using Probability May Help**

Solving the so called "contest type" mathematical problems is usually a challenge for everyone. Variety of methods are developed to approach such problems. One of the difficulties is that it is not clear at once which of the methods could be suitable for a concrete problem. This paper considers the use of probabilistic ideas for solving contest type mathematical problems which wording does not refer to probability. As other methods, this is not a universal one, meaning that it is not applicable to every contest type problem. However, this probabilistic method is a powerful tool and of use in combinatorics. It was introduced by Paul Erdős in the second half of 20-th century. The reason to bring the attention to it is that sometimes probability presents a different look at the problem and may help to arrive at the solution.

Regis Prado Barbosa

Department of Computer Science, Institute of Mathematics and Statistics,
University of São Paulo (USP), São Paulo, Brazil;
Colégio ETAPA, São Paulo, Brazil

prado.regis@gmail.com

**Combinatorics: How Could a Syllabus Shorten the Distance to Research?**

The IMO syllabus has been discussed and developed over several years. This document offers several advantages, such as helping new countries understand the topics that appear in mathematical competitions and guiding new directions for problem design. Considering this latter advantage, an interesting question arises: how can the syllabus be developed in a way that shortens the gap between mathematical competitions and research?

In the specific case of Combinatorics, I believe that by widely disseminating standard notation and illustrative examples, it is possible to introduce many more research-inspired topics into high school competitions. For example, if the notation and context are familiar to all participants, several problems involving extremal bounds and related concepts could naturally be included in competitions.

Miroslav Marinov

Institute of Mathematics and Informatics, Bulgarian Academy of Sciences, Bulgaria

m.marinov1617@gmail.com

**Erdős Problem 379 –**
**rows in Pascal's Triangle With Arbitrarily Large Maximal Prime Exponents**

In 2025 Cambie Kovač and Tao solved a problem of Erdős about determining whether for any constant $C$ there is an integer n such that for each binomial coefficient ($n$ choose $k$), $1 \leq k \leq n-1$, there is a prime $p$ with $p^C$ dividing it. They provided both an explicit construction via Euler's theorem on the totient function, and an argument relating to Diophantine approximations. In the beginning of 2026 this problem was proposed to two competitions, occurring at the same time, and additional constructions were found via the Lifting the Exponent lemma. We will discuss all approaches and the collaborative process behind them.

Evgeny V. Khinko

International Mathematical Tournament of Towns, Russia

evgeny.v.khinko@turgor.ru

**On Modern Methods of Cheating in Mathematical Competitions**

With the development of technology, and AI in particular, the good old-fashioned paper cheat sheets are becoming a thing of the past. My talk covers the cheating methods that organisers of school olympiads and competitions in Russia have managed to detect, and the methods devised so far to identify and halt them.

Alexander Soifer

University of Colorado, USA

asoifer@uccs.edu

**The Soifer Mathematical Olympiad is 40: A Film**

Written and produced by the University of Colorado media specialists, 34 min, 2025

The film traces a 40-year history of The Soifer (formerly Colorado) Mathematical Olympiad. It captures the entire process, from creating original problems to running the Olympiad and answering questions of middle and high school Olympians, to work of the Jury, lectures for the winners and contestants, congratulatory addresses by the leaders of the University of Colorado and school districts, Colorado Congressmen and donors.

The film depicts administrators who supported the Olympiad and those who hindered it, even ordered the Olympiad's closure. It shares with mathematical colleagues the process of creating mathematical Olympiads and, we hope, will inspire them to organize their own Olympiads.

**Topic Group 2**

# Creating Problems and Problem Solving

Hayk Sedrakyan

Coauthors: Nairi Sedrakyan, Christophe Pinarbasi

Independent research
sedrakyan.hayk@gmail.com, nairisedrakyan@gmail.com, cpinarbasi2010@gmail.com

## Keynote by Chair: Sedrakyan's Area Formula: A Unified Distance-Based Area Formula for Convex Polygons

This work fills an approximately 2000-year-old gap and is the structural missing link. Heron's formula dates back to approximately 60 AD and Bretschneider's formula to 1842, yet no such a unified distance-based formula existed for polygons with more than 4 sides. This work shows that these two formulas which looked completely different for centuries are in fact particular cases of a single general formula. The truly remarkable thing is not that it uses only side lengths and certain diagonal or distance lengths, but rather that one single unified formula computes the area of any convex polygon for any number of sides greater or equal to 3 (which is the key novelty), something previously thought impossible for polygons having 5 or more sides. Sedrakyan's area formula is a novel approach that overcomes the challenge of calculating the area of non-rigid polygons with five or more sides using only distances.

Robert Geretschläger

World Federation of National Mathematics Competitions

robert@rgeretschlaeger.com

## Tetrahedron Problems

With the IMO currently in the process of reconsidering the role of problems in solid geometry, a fresh breeze appears to be blowing through this topic area. While simple problems in solid geometry have never stopped being staples of popular competitions, such matters have been relegated somewhat to the fringes of higher-level competitions in recent decades.

Now that geometric problems in three dimensions appear poised to shift toward greater visibility in the competition world, it would seem to be a good time to take a closer look at some of the wonderful problems of this type that have been posed in competitions over the years. Starting from these, we can also consider some ideas that can be used to create new interesting problems.

In my talk I will present some problems of this type that specifically concern tetrahedra, the simplest of the three-dimensional solids.

Arno Mikaelyan, Advik Kishore

Coauthor: Hayk Sedrakyan

Independent research

sedrakyan.hayk@gmail.com, arnomikaelyan08@gmail.com, advikkishore1@gmail.com

**Trapezoid Law, Trapezoid Theorem and Their Applications**

We establish several novel geometric results. Specifically, we present a generalization of the parallelogram law – which we term the Trapezoid Law – and a stronger result, the Trapezoid Theorem, which provides explicit formulas for the diagonals of a trapezoid in terms of its side lengths. We also investigate the diverse applications of these results. In the literature, there are two distinct definitions of a trapezoid. The first defines a trapezoid as a quadrilateral with exactly one pair of parallel sides, while the second defines it as a quadrilateral with at least one pair of parallel sides. The Trapezoid Law demonstrates that a parallelogram can be considered a particular case of a trapezoid; therefore, the inclusive definition (at least one pair of parallel sides) is mathematically more appropriate. Much like a square is a special case of a rectangle, a parallelogram is a special case of a trapezoid.

Raphaël Pinarbasi

Coauthors: Hayk Sedrakyan, Nairi Sedrakyan

Independent research

sedrakyan.hayk@gmail.com, nairisedrakyan@gmail.com, pinarbasiraphael03@gmail.com

**Generalizations of Sedrakyan's Inequality (Titu's lemma) and Equality Conditions**

We establish several generalizations of Sedrakyan's inequality, also known as Titu's lemma or Engel's form and derive the explicit equality conditions for each. Alongside the Cauchy–Schwarz inequality, these are regarded as some of the most important and useful inequalities in mathematics. Published by Nairi Sedrakyan in 1997, the inequality was subsequently published and popularized by Arthur Engel in 1998 and Titu Andreescu in 2003. Whereas Engel, Andreescu and Bergström addressed only the basic case for squares, Sedrakyan provided the general form for arbitrary powers; these versions were also later featured in the book Algebraic Inequalities by the Sedrakyans.

Jacob Gechlik, Diya Gandhi, Shaurya Jain

Independent research

jacob.gechlik@gmail.com, diyagandhi7000@gmail.com, shaurya0508@gmail.com

**Creating Problems and Problem Solving. Some Properties for Hexagons**

This work presents a collection of mathematical problems and results that connect algebraic problem–solving techniques with geometric findings in two parts. The first part explores methods commonly used to solve and create Olympiad mathematics problems, including the shoelace formula, the rearrangement inequality, and Sturm's method, demonstrated through select examples. The second part investigates the unique properties of hexagonal parallelogons, focusing on their side lengths, diagonals, cyclicity, areas, midpoint configurations, and relationships with vectors. Together, these results offer a range of approaches and perspectives that support both the solution and creation of challenging mathematical problems.

**Topic Group 3**

## Competitions Around the World (Focus on Developing Countries)

Paul Vaderlind

Stockholm University, Stockholm, Sweden

paul@math.su.se

### Keynote by Chair: Challenges and Obstacles when Organising Competitions in Developing Countries

Around 60% of countries worldwide participate in the IMO. Even more countries now hold some form of mathematical Olympiad, whether local or national, and this number continues to grow. For example, Ethiopia, with a population of 130 million, had no maths competitions before 2023.

Almost all the "new" countries that introduced maths competitions in the last two decades are what we today refer to as "developing countries" or the "Global South". Some of these countries have joined the IMO and quickly climbed up the rankings. Unfortunately, many have remained at the bottom of the rankings throughout their participation in the IMO, even after 10–15 years.

We can identify some of the key challenges facing organisers in establishing a well-functioning competition tradition. Countries with decades of experience could certainly contribute to solving some of these challenges by sharing their knowledge and successful practices.

Maria Losada

Universidad Antonio Nariño Bogota, Colombia

director.olimpiadas@uan.edu.co

### Some Remarks on Colombia's National Mathematical Olympiad

A small talk on Colombia's National Mathematical Olympiad.

Krzysztof Ciesielski

Jagiellonian University, Mathematics Institute, Kraków, Poland

krzysztof.ciesielski@im.uj.edu.pl

**From University Entrance Examination to a New Kind of Competition**

For many years, entrance examinations for higher education have been organised in Poland. In order to study mathematics, secondary school graduates had to pass a mathematics examination. For many years, candidates had to solve five classic problems during a written examination and pass an oral examination. At the end of the 20th century, we decided to replace the oral exam with a multiple-choice exam, and after a few years, both tests were replaced with a new, untypical kind of exam. These rules remained in force for some years, until the admission rules for Polish universities began to be organised differently. However, our tests proved to be so interesting that we organised competitions for students based on this method. In my presentation, I will describe these types of tests/competitions, explain why this new type of testing has proven to be better, and present several examples of problems from these tests, especially those that have been given to university students.

Navid Safaei

Institute of Mathematics and Informatics, Bulgarian Academy of Sciences, Sofia, Bulgaria

navid@math.bas.bg

**The Friendly Competitions (Common IMO Preparations for Several Countries)**

The preparation of IMO teams for the International Mathematical Olympiad (IMO) has become more and more serious. The competition between and hence the competitiveness of each country is now heavily relying on the dynamic capabilities of the well-trained competitors, that, per se, would be the outcome of the preparation they have taken. One dimension of this preparation is the simulated competitions before the IMO. Since 2002 and as a director of preparation of IRAN team for the IMO, I started several IMO-styled friendly competitions between the IRAN IMO team and the IMO teams of Belarus, Taiwan, Singapore (since 2023), India (since 2024), Brazil (since 2023), and Mongolia (since 2025). In this talk, I would like to describe the mechanisms of these friendly competitions, in line with presenting some of their problems, results, and explaining how positively they helped our students to better know their points of weakness as well as their rivals. There are even stronger reasons to organize such events, since they will pave the way for future scientific collaboration.

Agrey Stephen Kimaro

Numbers Foundation – Tanzania Mathematics Olympiad (TAMO), Tanzania

agrey.kimaro@gmail.com

## Finding the Mathematicians We Never Meet
## Building Inclusive Mathematics Olympiad Ecosystems in East Africa

`The Hidden Talent Gap.` Across sub-Saharan Africa, millions of students have no connection to Olympiad training or mentorship. UNESCO reports only 10.8% of African children reach minimum proficiency in reading and mathematics by the end of primary school, while over 39% of the world's out-of-school youth are in the region. Because entry to competitions typically depends on teacher nominations and school-level awareness, current systems identify prepared students, not necessarily the most talented ones – leaving rural, gifted students with a near-zero chance of being discovered.

`Why Traditional Models Miss Talent.` The classical announce-select-send model assumes self-selection, an assumption valid in well-resourced systems but not in East Africa, where uneven teacher networks, transport costs, and unreliable communication create friction that disproportionately excludes rural and lower-income students. Nomination-based systems therefore over-represent already-advantaged students, turning Olympiads into mechanisms of selection rather than discovery.

`The Ecosystem Model.` A more productive framework treats Olympiad programmes as ecosystems, not one-off events, built on six interdependent pillars: Awareness (active outreach to rural and underserved schools), Access (removing cost and logistical barriers), Development (year-round clubs, mentorship, and coaching), Recognition (competitions as milestones, not the whole system), Leadership (former participants becoming coaches, creating generational renewal), and Sustainability (partnerships with ministries, universities, and diversified funding). Weakness in any one pillar limits the rest.

`Inclusion Is How Excellence Is Found.` Broadening participation is often assumed to trade off against rigor. Evidence from East Africa suggests the reverse: doubling school reach doubles the talent pool feeding into genuinely rigorous selection, producing stronger national teams. The same logic applies to gender – girls are globally underrepresented in mathematics competitions due to socialization and structural barriers, not ability, so targeted outreach and female mentors correct a systematic undersampling of talent rather than lowering standards.

`Teachers and Mathematics Clubs.` Teacher training offers the greatest leverage in the ecosystem: a single trained teacher can introduce competition mathematics to hundreds of students across a career, far exceeding what any individual coach can reach directly. Weekly mathematics clubs, not annual competitions, are where sustained engagement, problem-solving persistence, and mathematical identity are actually built – and they offer a safer, lower-stakes entry point for girls and under-resourced schools.

`Regional Collaboration and the Tanzania Case.` Tanzania, Kenya, Uganda, Rwanda, and Ethiopia have built shared regional infrastructure – joint training camps, coach exchanges, shared problem databases, and cross-border female mentor networks – anchored by the East African Mathematical Olympiad. In Tanzania, the Numbers Foundation's TAMO programme reached over 47 schools across 31 regions and more than 5,000 students, trained over 100 teachers, and lifted female participation to roughly 35%, demonstrating that the ecosystem model produces measurable results at scale.

`Challenges and the Path Forward.` Persistent funding constraints, teacher shortages, volunteer burnout, and the sheer geographic scale of East Africa remain real operational challenges requiring long time horizons rather than short-term metrics. Looking ahead, digital tools and online mentorship can extend reach into remote communities, formal government integration can stabilize funding and legitimacy, and AI-assisted problem generation and personalized training pathways represent an emerging opportunity for the development pillar.

`Conclusion.` The future of mathematics Olympiads depends not on how hard the problems become, but on how many young minds get the chance to solve them. The ecosystem model is not theoretical – it is a working description of what high-impact programmes already do. Somewhere today, another future mathematician is waiting not to be selected, but to be found.

**Topic Group 4**

## Technological Applications in Mathematics Competitions and Didactics

Lukas Donner

Georg-August-Universität Göttingen, Mathematisches Institut, Germany

lukas.donner@mathematik.uni-goettingen.de

### Keynote by Chair: Variation of a Competition Problem – From Placement of Sticks, Residue Classes and the Binary System

In my presentation, I would like to provide a brief overview of the expected contributions from the TG and highlight possible connections between them. In addition, I would like to focus on task variation, both from the perspective of task design and from the perspective of variation as an explicit student activity. The presentation will include a specific competition task for students of grade 3-4 (and variations of it) as well as theoretical considerations.

Andrew Kepert, Elke Grinschgl, Lukas Donner

AK: University of Newcastle, Australia
EG, LD: Georg-August-Universität Göttingen, Mathematisches Institut, Germany

Andrew.Kepert@amt.edu.au,
elke.grinschgl@mathematik.uni-goettingen.de,
lukas.donner@mathematik.uni-goettingen.de

### Austrian Kangaroos and Australian Kangaroos: Similarities and Differences

The Mathematical Kangaroo (Kangourou Sans Frontières competition) is an annual competition and enrichment activity for school students in over 100 countries. Each version of KSF has localised language, competition questions, rules and awards chosen to suit the local context. We will discuss our preliminary work comparing students' performance in KSF questions and papers in Austria and Australia, and what this comparison reveals about how various competition questions perform in different environments.

Matjaž Željko

University of Ljubljana, Faculty of Mathematics and Physics, Slovenia
Society of mathematicians, physicists and astronomers of Slovenia

matjaz.zeljko@fmf.uni-lj.si

## International Kangaroo Open

Kangaroo contest is a worldwide contest held on 3$^{rd}$ Thursday in March aimed for students of all levels and is being held in almost hundred countries with more than six million participants. In October 2025 the idea emerged to organise a free online mathematics competition at the same time as the official Kangaroo competition. The goal of this contest is to reach wider audience: parents and teachers of participating contestants and to strengthen the Kangaroo brand globally.

The contest was named "The International Kangaroo Open". In order to keep the system small the contest was started with limited number of pilot countries. Two difficulty levels were offered with 24 problems each. Problems were offered in 8 languages. Problems were taken from old Kangaroo contests. The competition was free of charge, open to everyone and even multiple attempts were allowed. Participants could see their score immediately after completing the contest, and after the one-month competition period more detailed statistics was available. The contest was run in GDPR friendly manner: no personal data was collected and no registration for the contest was necessary.

At the end more than 14000 participants from over 50 countries took part. Almost 4% of participants got a perfect score. Based on the (very) positive feedback from participants and pilot countries we will continue to run the contest. For the future we plan to promote the contest through more participating countries while trying not to over-expand to keep the system manageable.

Robin Gludovatz, Yasmin Theile, Michael Fischer

University of Vienna, Austria
University of Cologne, Germany
University of Graz, Austria

robin.gludovatz@univie.ac.at, ytheile1@uni-koeln.de, michael.fischer@uni-graz.at

## The Digital Gap: Analysing Performance Differences in Online vs. Offline Mathematics Competitions

International mathematics curricula outline a range of objectives for students. Among these, two goals are consistently and prominently emphasized: fostering deep problem-solving skills and integrating digital tools into mathematics education. The digitalization of a large-scale competition offers a critical testbed to examine the interplay between these two aims.

The "Kangaroo" mathematics competition serves as an ideal subject for this investigation. As the world's largest school mathematics contest, involving participants from over 100 countries since its international inception in 1995, it provides a robust framework. Our analysis focuses on data from Austria ($n = 30000$), where the digital version ($n = 3000$) has been introduced as a direct, task-by-task replica of the paper-based format. This design allows for a unique examination of the medium's effect, isolated from changes in content.

Preliminary descriptive data from Austria since 2023 reveal a consistent and concerning trend: participants achieve lower scores in the online version compared to the offline format across consecutive years. Our findings suggest a significant negative effect associated with the digital format of around 10%.

To understand the roots of this "digital gap", we conducted a qualitative content analysis of the competition tasks. We identify and examine the "most problematic" items, those exhibiting the largest performance drop in the digital setting. This analysis aims to uncover specific characteristics of mathematical problems that may be particularly sensitive to the digital medium, such as the presentation of multi-step problems, spatial reasoning tasks, or the management of on-screen information.

This study offers valuable insights for the design and implementation of digital mathematics assessments. By highlighting task types that may be disadvantaged in a direct digital transfer, our work provides educators and competition organizers with a foundation for more deliberate and effective digital integration.

Evita Lerchenberger

University of Graz, Austria

evita.lerchenberger@uni-graz.at

## Why Translation Is Not Enough: Problems, Ideas And (Partial) Solutions For Blind Participants In The Mathematical Kangaroo Competition

While there are some projects for blind students relating to their mathematics learning process (e.g. Beck-Winchatz & Riccobono, 2008; Hill et al., 2023; Leuders, 2016), the field of students' performing in tests or competitions has received little attention. However, in terms of diversity-fair inclusion, it is particularly important also to enable positive emotional experiences with mathematics in addition to participation, because there are often few barrier-free opportunities for these students.

This article focuses on two aspects of adapting tasks for blind participants in the Mathematical Kangaroo:
On the one hand, I would like to show how (technical) features such as Braille displays or tactile print graphics make it possible for blind learners to read and work on tasks, but at the same time I would like to point out the limitations by showing the differences that arise from this approach compared to sighted participants. This provides a good link to the second aspect of the talk: the didactic comparison of tasks, or more precisely, their possible solutions for sighted and blind participants. A simple "translation" of the tasks changes the content of some tasks for blind participants. After analysing some tasks (under selected aspects as mentioned in Leuders, 2023) with regard to the question "What knowledge and solution steps are necessary to solve the task?", the aim is to show that some tasks require a more thoughtful adaptation in order to achieve an approximately equal level of difficulty and thus fairness. I would like to place a special focus on tasks for school grades 5 to 8 and, in particular, highlight some specific barriers in tasks that are considered "easy".

Observations of blind students in the competition situation should provide insights not only for future adaptations of tasks in the Mathematical Kangaroo or other competitions, but also for possible learning settings. This can also lead to a discussion about how this "tangible" or multimodal approach to mathematical problems can be beneficial for the learning process of all students.

## Extra Presentations

Omar Colón, Luis Cáceres

University of Puerto Rico, Mayagüez Campus, Puerto Rico
omar.colon4@upr.edu, luis.caceres1@upr.edu

### Promoting Geometric Reasoning Through the Development of a New Mathematics Competition in Puerto Rico

Geometry is one of the most significant areas in international mathematical competitions. In high-prestige events such as the International Mathematical Olympiad and the Ibero-American Mathematical Olympiad, traditionally about one-third of the examination consists of geometric problems. Despite its relevance, in Puerto Rico's school system, the study of geometry has lagged behind algebra or arithmetic, being largely limited to basic definitions and postponing advanced concepts until the high school level. As a consequence, when Puerto Rican students begin their preparation for international Olympiads, coaches must start from the conceptual foundations due to the lack of prior exposure.

With the primary objective of addressing this gap, strengthening the presence of this discipline, and actively promoting geometric reasoning in the island's school system, the Puerto Rico Mathematical Olympiads (OMPR) program initiated the development of a specialized competition: the Puerto Rican Geometry Olympiad (OPG).

Unlike other traditional competitions, the Geometry Olympiad is designed to cover a broad educational spectrum, integrating students from first grade of elementary school to twelfth grade of high school. The call is inclusive, allowing the participation of students from public schools, private schools, and the homeschooling modality.

The technical and institutional functioning of the Olympiad is handled by a commission that defines the organizational calendar and the selection of problems. For example, in the first phase of the edition corresponding to the 2025-2026 cycle, the evaluation was structured through a digital form consisting of 10 multiple-choice problems (from A to E). The proposed problems are rigorously classified by competition levels to precisely evaluate problem-solving skills, systematically identifying the areas of greatest and least difficulty for the participants.

The first official edition of this dedicated Olympiad was held in 2026. This initial experience served to collect valuable statistical and qualitative data on the state of geometric education on the island. Among the analyses under development from the results are the evaluation of participation volume broken down by geographical regions, performance by specific topics, and the study of how this type of competition can improve students' geometric reasoning in the long term.

This presentation describes the structure of the competition, provides representative examples of typical problems, and discusses the outcomes of its first edition, held in 2026.

Tim Sanders

mathleague.org, USA

tim@mathleague.org

**Developing an Early Childhood Contest**

Almost two decades ago, mathleague.org started an elementary school contest for students in grades 3–6 because so many younger students were enrolling in our more advanced contests and were asking for a formal program in their age range. In that time, our organization has seen a large number of very young participants in this contest requesting a contest appropriate for students in second grade and below. As a result, after years of development, mathleague.org is launching an Early Childhood contest in the fall of 2026.

Creating a contest for such a young audience presents unique challenges not faced by organizers of contests designed for older students. For example, below a certain age students may have little or no experience reading written language, so this must be taken into account. Furthermore, a new class of test items needs to be developed that can adequately assess and challenge the skills of such young participants. Perhaps most importantly, very young children may not be ready to handle the competitive pressure we regularly ask high school students to endure, so the very structure and nature of the contest needs to be carefully planned out.

This paper details the research and decision points that went into developing our Early Childhood contest, as well as what we learned from our pilot test in spring 2026.

Nicolás Atanes Santos

Universidad Nacional de Educación a Distancia, Spain

nicatasan@gmail.com

**Strategies for Developing and Sustaining an Engaging Mathematics League**

In efforts to disseminate mathematics, and to encourage a mathematics competition that is played throughout the year, the concept of Mathematics League emerged. Although it is not easy, the result is to make mathematics, like sports, popular and exciting for a longer time. This talk will explain the concept of a Mathematics League and some recommendations for creating one at the university level.

Michael Fischer

University of Graz, Austria

michael.fischer@uni-graz.at

**Teamwork and Task Design in Mathematics Team Competitions: Students' Experiences and Organizers' Reflections**

In recent years, team competitions have become an increasingly visible complement to traditional individual formats such as mathematical olympiads or the Kangaroo competition. This development shifts attention to the social dimension of mathematical engagement. From the perspective of interest research, it invites a distinction between interest in mathematics as a domain and interest in mathematics as experienced through a specific collaborative activity.

This contribution reports on an exploratory questionnaire study of students' experiences in team-based mathematics competitions. Data were collected through short paper-and-pencil questionnaires from 564 students participating in three competition formats: Mathe-Mix-Doppel, m3, and Náboj. These formats differed in team size, ranging from pairs to teams of five students. The questionnaire combined open-ended questions with number-line rating items. Open responses were analysed using qualitative content analysis. The coded responses were then examined using descriptive statistics, confidence intervals, chi-square tests, and exploratory logistic regression.

The ratings indicate that students evaluated both the overall competition experience and their collaboration within the team positively. The results also show that teamwork was the most frequent coded category in students' open feedback. Moreover, the proportion of students explicitly mentioning teamwork increased across the three formats, from the two-student format to the three- and five-student formats. This pattern is supported by an exploratory logistic regression model, although it must be interpreted cautiously because team size and competition format are confounded.

The second part of the contribution broadens the perspective from students' enjoyment to the design of team competitions. Drawing on further open-question responses and organizational documentation from running several team competitions over multiple years, we discuss task-related feedback, expected solution paths, misleading solution attempts, answer formats, age-appropriate difficulty, and observed solution rates. The contribution therefore combines empirical evidence on students' experiences with practice-oriented insights into the design and organization of mathematical team competitions.

Chris Wetherell

Australian Maths Trust, Australia

Chris.Wetherell@amt.edu.au

**Sharing the Love: Experiences from the Australian Maths Trust**

Put simply, the Australian Maths Trust exists to promote a love of mathematical and algorithmic problem solving. The scope of this work encompasses the full school experience, from the youngest students just starting their educational journey to the brightest minds who go on to represent Australia on the world stage. In this talk, we will focus on the work we do to identify and support students at the pre-Olympiad level, particularly through the well-established Maths for Young Australians program, as well as new initiatives aimed at broadening our reach both domestically and in the Asia-Pacific region.

Aidan Mozayeni

coauthor: Hayk Sedrakyan

AM: undergraduate Princeton University, USA; HS: Independent research

aidan.mozayeni@outlook.com, sedrakyan.hayk@gmail.com

**Formulas for Diagonals of any Quadrilateral**

Novel formulas for the diagonals of any quadrilateral are given and proven. The novelty of this work is in the ability to represent each diagonal of any quadrilateral separately. We provide formulas for representing a diagonal of any cyclic quadrilateral, as well as a formula of representing a diagonal of any quadrilateral.

Athmane Dadi

Champs School Draa El Mizan, Algeria

syphaxdadi@gmail.com

**Bridging the Gap Between School Mathematics and Competition Thinking: Insights from International Practice, with a Focus on Developing Countries**

My presentation will discuss the gap between school mathematics and competition mathematics, highlighting how competition thinking can help improve curricula, teaching practices, and students' reasoning skills, particularly in developing countries.

© 2026 WFNMC. All rights reserved.